Second Edition

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Horizontal Auger Boring Projects

Horizontal Auger Boring Task Force

Edited by
Alan Atalah, Ph.D., P.E.
Lameck Onsarigo, Ph.D.

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UTILITY ENGINEERING & SURVEYING INSTITUTE

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Prepared by the
Horizontal Auger Boring Task Force of the
Trenchless Installation of Pipelines Committee of the
Utility Engineering and Surveying Institute of the
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A manual or report in this series consists of an orderly presentation of facts on a particular subject, supplemented by an analysis of limitations and applications of these facts. It contains information useful to the average engineer in his or her everyday work, rather than findings that may be useful only occasionally or rarely. It is not in any sense a "standard," however; nor is it so elementary or so conclusive as to provide a "rule of thumb" for nonengineers.

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In February 1962 (and revised in April 1982), the Board of Direction voted to establish a series titled "Manuals and Reports on Engineering Practice," to include the Manuals published and authorized to date, future Manuals of Professional Practice, and Reports on Engineering Practice. All such Manual or Report material of the Society would have been refereed in a manner approved by the Board Committee on Publications and would be bound, with applicable discussion, in books similar to past Manuals. Numbering would be consecutive and would be a continuation of present Manual numbers. In some cases of joint committee reports, bypassing of Journal publications may be authorized.

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PREFACE

There are several different trenchless technologies. Horizontal auger boring (HAB) is one of these and is the focus of this manual of practice (MOP). The first ASCE MOP for auger boring projects was developed in 2004 by the Auger Boring Task Force of the ASCE Committee on Trenchless Installation of Pipelines (TIPS). This MOP was the first in a series of MOPs that have promoted best practices and developed a knowledge base for auger boring projects. Since then, there have been advancements in HAB technology. Therefore, the Auger Boring Task Force established by TIPS has issued this updated and comprehensive edition.

This MOP will assist engineers, contractors, and owners involved in new pipe installation projects that use the HAB method to design and carry out projects effectively and safely, in conformance with project requirements and site conditions. The objective of this manual is to present a clear understanding of the method, its capabilities, and limitations; outline important design and construction considerations; and identify potential problems along with prevention and mitigation measures. The task committee understands that various trenchless technologies may be combined to form hybrid trenchless methods. However, this MOP will focus on the mechanics of the basic HAB means and methods with currently available equipment. These guidelines are based on information compiled from manufacturers' literature, field experience, technical papers, and other related information, and from comments and reviews made by the Blue Ribbon Committee.

The task committee would like to thank all the task committee members and reviewers for their support, time, and effort.

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ABBREVIATIONS, ACRONYMS, AND INITIALISMS

A/O TV	acoustic/optical televiewer
AASHTO	American Association of State Highway Transportation Officials
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BMTA	boring machine tunnel attachment
BVR	boulder volume ratio
CBS	controlled boring system
CCFRPP	centrifugally cast fiberglass reinforced plastic pipe
CVR	cobble volume ratio
DOT	Department of Transportation
DSC	differing site condition
DTH	down-the-hole
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GBM	guided boring method
GBR	geotechnical baseline report
GDM	geotechnical design memorandum
GDR	geotechnical data report
GIR	geotechnical interpretive report
GPR	ground-penetrating radar
GWT	groundwater table
HAB	horizontal auger boring
HEB	horizontal earth boring
HDD	horizontal directional drilling

HDPE	high-density polyethylene
HSA	hollow stem auger
ISRM	International Society of Rock Mechanics
ISTT	International Society for Trenchless Technology
LDBA	large-diameter boring attachment
LED	light-emitting diode
MIG	metal inert gas
MOP	manual of practice
MT	microtunneling
MTBM	microtunneling boring machine
NASTT	North American Society for Trenchless Technology
NDT	nondestructive testing
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PI	plasticity index
PJ	pipe jacking
PTM	pilot tube method
PVC	polyvinyl chloride
QL	quality level
RPMs	revolutions per minute
RQD	rock-quality designation
SBU	small boring unit
SBU-A	SBU-auger
SBU-M	motorized SBU
SBU-RH	SBU rock head
SPT	standard penetration test
SUE	subsurface utility engineering
TBM	tunnel boring machine
TIPS	trenchless installation of pipelines
UCS	unconfined compressive strength
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
UT	utility tunneling
UTRC	Underground Technology Research Council

CHAPTER 1
GENERAL

There is a significant demand for underground infrastructure to transport our drinking water, wastewater, stormwater, natural gas, oil, and power. Once every four years, the American Society of Civil Engineers (ASCE) provides a comprehensive assessment of the nation's major infrastructure categories in the *Report Card for America's Infrastructure*. Using a simple A to F school report card format, the *Report Card* provides a comprehensive assessment of current infrastructure conditions and needs, assigns grades, and makes recommendations for how to raise the grades (ASCE 2013).

According to the 2013 *Report Card*, the grade for drinking water, wastewater, and stormwater systems improved slightly from a D– to a D from 2009 to 2013. Many of our drinking water, wastewater, and stormwater systems are nearing the end of their useful life. There are an estimated 240,000 water main breaks per year in the United States. If every pipe needed to be replaced, the cost over the coming decades could reach more than $1 trillion. Capital investment needs for the nation's wastewater and stormwater systems alone are estimated to total $298 billion over the next 20 years. Pipes represent the largest capital need and comprise three-quarters of the total infrastructure needs. Rehabilitating to extend life spans and upgrading and expanding the network with new pipes will address many of the sanitary sewer overflows, combined sewer overflows, and other pipe-related issues (ASCE 2013).

The grade for energy remains a D+; America relies on aging pipeline transmission and distribution systems, some of which originated in the 1880s. The increased demand for natural gas and oil will become a greater challenge after 2020 as the population increases (ASCE 2013). Even with

substantial shifts to "green" energy sources, energy still requires transmission from its source and distribution to the consumer.

Invisible underground infrastructure is the foundation of our current civilization and future prosperity. They permit the concentration of resources required to grow our economy. The underground infrastructure is failing due to a lack of proper maintenance and asset management practices. Underground infrastructure has been getting less attention than aboveground infrastructure because underground infrastructure is out of sight and out of mind (Salem et al. 2008). However, it requires maintenance, repair, rehabilitation, and replacement in an economical and safe manner that causes minimal capital, environmental, or social costs to taxpayers.

Proper maintenance requires the periodic inspection of these underground assets. After inspection, remedial action is taken, as needed, and may include cleaning, repair, rehabilitation, or replacement. Significant improvements in pipe rehabilitation technologies in recent years have provided a significant cost benefit to extend pipeline life, but new installations remain a critical component of upsizing and expanding our infrastructure to handle today's rapid population growth. However, if a pipe needs to be replaced or a new pipe is needed, construction is limited to the traditional open-cut methods or the trenchless technologies. Traditional open-cut construction involves the following activities: exploring existing utilities, diverting traffic, excavating, shoring, dewatering, laying the pipe, backfilling, and restoring the site. Excavated urban materials are often contaminated and may need to be disposed of at an off-site location, requiring backfill material to be transported to the site. In urban areas, these activities can cause significant disturbance to traffic, the environment, local businesses, and residents; therefore, trenchless technology is the preferred option for pipeline installation.

The North American Society for Trenchless Technology (NASTT) defines trenchless technology as a family of construction techniques for installing or rehabilitating underground infrastructure with minimal disruption to traffic, businesses, and residents (NASTT 2013). This definition also includes technologies for inspection, leak detection, and leak location with minimal disruption and minimal excavation from the ground surface. When employed appropriately, trenchless technology is an economical and convenient alternative to open-cut construction (Atalah and Kariuki 2009).

Chapter 1 of this MOP discusses the importance of trenchless technology and its role in addressing the water, wastewater, oil, and gas pipeline issues mentioned above. The chapter presents an overview of the horizontal auger boring (HAB) process, along with alternative trenchless techniques used to install new water and wastewater lines.

1.1 SCOPE OF THIS MOP

This MOP presents HAB technology and its application to utility construction projects. Chapter 2 of this manual examines the mechanics of the HAB system, including the different components and attachments, along with recent innovations in the technology. The rest of the chapters present and discuss the different phases of a HAB project: the planning phase (Chapter 3), the geotechnical investigation process (Chapter 4), the design and preconstruction phase (Chapter 5), and the project construction phase (Chapter 6).

It is always a challenge to determine the level of detail in an MOP for a technology like HAB because it is highly adaptable and is applicable over a wide range of conditions. HAB can be used to install simple, short, and unsteered casings in uniform ground. The method can also be used to install complicated long crossings in challenging ground and environments. The level of project risk typically determines the complexity. Low-risk projects are often completed with little preconstruction phase activity (planning, geotechnical exploration, and design); the assumption is that the risks will be dealt with if and when they are encountered. Risky and challenging projects typically involve extensive planning, exploration, and design prior to the construction phase. This manual is written to address the installation of a typical carrier pipe with low to moderate risks and challenges. For these projects, the owner and engineer are typically faced with a series of judgment calls on the number of preconstruction activities needed to identify the level of risk involved, the challenges, the parties' experience, the project's contracting mechanisms, and the associated environmental and social issues.

1.2 WHY TRENCHLESS TECHNOLOGY?

More and more projects are now being assessed by processes called lifecycle cost or triple bottom line costing. These methods assess the total project cost, including the direct, premium, operation, and maintenance costs over the project life, along with the social and environmental costs. When premium, social, and environmental costs are added, trenchless technology costs become lower than open-cut technology costs. It is these total cost savings that have been driving the past and current rapid market growth of trenchless technologies.

Direct costs—which consist of the costs of labor, material, equipment, and associated business expenses—are an important factor in the selection of the construction method. The direct costs of a pipeline project depend on direct controllable factors, including the pipe size (diameter),